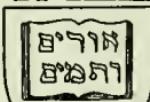


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ON THE APPLICATION
OF
GALVANIC ELECTRICITY TO MEDICINE.

Read to the Lexington Medical Society, December 2d, 1836.

BY ROBERT PETER, M. D.

WHEN, in the year 1790, Galvani, whose name is immortalized by its connection with the branch of science to which his observations gave rise, noticed that when a spark from an electrical machine was taken by a person standing near another engaged in dissecting a frog, who had his scalpel in contact with a nerve, that the limbs of the frog were immediately convulsed;—and when this philosopher subsequently discovered that if a nerve and a muscle of a frog be brought into connection by means of a clean metal, convulsions were equally produced in the muscles of the dead animal,—he believed that for him had been reserved the discovery of the nature of that mysterious agent in vital contraction, the nervous fluid.

Volta, however, soon established the fact that the cause of the contractions, in the cases observed by Galvani, was not the animal nervous, or electrical fluid, but a current of electricity, analogous to that of the common machine, which was produced by the contact of dissimilar metals, or by the action of dissimilar fluids on a single metal. The discovery of the fact that the contact, and action upon each other, of bodies of a dissimilar nature, always caused the formation of currents of electrical fluid, brought the physiological experiments of Galvani within the pale of what had already been long known,

and disappointed the expectations of those who believed that the nature of the nervous fluid, and perhaps of vitality itself, was about to be unveiled to the understanding of man. Since that period, muscles in all parts of the dead body have been made to contract by the agency of the galvanic fluid;—even the heart itself, in a recently dead subject, has been caused to beat;—the peristaltic motion of the intestines has been renewed; the function of digestion has been restored, after the nerve going to the stomach has been cut; and in a living body, diseased and paralized nerves have had their healthy action re-established, by a galvanic current;—even a fibrous substance, analogous to muscular fibre, has been generated, by M. M. Prevost and Dumas, in yolk of egg, under the influence of the pile;—yet we are but little nearer, perhaps, to the solution of the mystery of life and nervous action than we were in the day of the discovery of Galvani.

The progress of discovery, in this interesting branch of science has not, however, been entirely stayed. Many analogies between the actions of an electrical current and nervous actions have been made out, as well as many new and successful applications of the former agent, the electrical current, to the removal of disease. On the analogies existing between the actions of electricity and of the nervous influence, and on the applications of the former to medicine, I propose to base the present paper. It is not my intention to go into the minutiae of the subject, as the time allotted would not permit, could I even hope to carry your attention with me, but merely to give some of the most prominent and obvious of the facts which have been established.

To commence with some of the analogies between the actions of electricity and the nervous power, we will examine, first, the production of muscular contractions by means of electricity. It has long been known that a current of electricity causes contraction in animal muscles, and every one who has experienced a shock from a Leyden jar, has had an evidence of the fact in his own person. Contraction in this case is sudden and violent, so much so, that when, in 1746,

Cuneus and Muschenbroek, who discovered this piece of apparatus, first experienced its effects, they were so much terrified that one declared that he would not submit to another shock for the whole kingdom of France, and the other dieted himself for a week, and took cooling medicines to correct fever. Similar contractions are produced in recently dead bodies. The Leyden jar causes a sudden and instantaneous current of electricity, but the Galvanic battery produces a current of longer continuance, and hence its effects are more striking. Galvani, in the severed head of an ox that had recently been killed, caused the eyes to open, the ears to shake, the tongue to move, and the nostrils to expand, by the action of a Galvanic pile of one hundred pairs of silver and zinc plates, one pole of which was placed in connection with the nose, the other being placed in the ear. M. De Humboldt took a Linnet, on the point of expiring, its eyes were closed and it could no longer support itself on its legs. He placed a small plate of zinc in the beak, and another of silver in the rectum, joining them together, out of the body, by an iron wire; at the moment of contact the bird opened its eyes, raised itself on its feet, flapping its wings. It respiration for six or eight minutes, and then tranquilly expired.

By a similar arrangement, viz., a piece of silver on the tongue and a piece of zinc in the rectum, joined by a wire, Achard, of Berlin, caused an increase of the peristaltic motion of the bowels, in his own person, and a dejection of faecal matters. This arrangement is now, in fact, in fashion, in some parts of our country, for the same purpose, and it has been found to cause alvine discharges when other means have failed. Some interesting facts relative to this piece of apparatus may be found in the present volume of this journal, in the paper of T. L. Caldwell, M. D. In persons recently dead, contractions of most of the muscles have been produced by the galvanic fluid:—for a striking account of one case, that of a hung malefactor, who was galvanized by Dr. Ure, I beg to refer to Ure's *Chemical Dictionary*, Art. *Galvanism*.

Another analogy exists in the production of Tetanus by Galvanic electricity. In certain disorders of the nerves involuntary contraction of the muscles, called tetanus, occurs; a similar contraction may be produced or removed by galvanism. M. Nobili, in exposing frogs, prepared for electrical experiments, to the action of a galvanic current, found that some of the vigorous individuals had their limbs stiffened so that they could with difficulty be bent. Sometimes the animal extended and stiffened its limbs as though they suffered a tetanic convolution, which continued for some time. He rendered the contractions permanent by alternately interrupting and re-establishing the galvanic circuit; and he, moreover, found that while the current was continued in one direction the tetanic contraction continued, and that when the direction of the current was changed the spasm of the muscles was removed.

Another analogy.—By continued exercise of the nervous system, whether by motion, sensation, or intellection, fatigue or lassitude is the result. Electricity is capable of producing the same result, as is evident in the following case, recorded by M. Rozet, in his “Travels in the regency of Algiers,” in which the effect was produced by a disturbance in the electrical equilibrium of the atmosphere, and of the surface of the earth. “On the 8th of May, 1831, after the setting of the sun, all the atmosphere was on fire and announced a violent storm. On the ends of the flag-staffs at Algiers, there could be seen a white light in the form of an *aigrette* or brush, which persisted for half an hour: some officers who were walking on a terrace, were much astonished to feel their hairs become erect, and to see a little *aigrette* of light on each of those of their comrades. On elevating their hands *aigrettes* formed also at the ends of their fingers. All the persons who were exposed to the action of the atmospherical electricity, suffered nervous contractions in their limbs, and a general lassitude, particularly in the legs.” Every one knows that life, even to the last vestige of irritability, may be instantly destroyed by the influence of a large charge of electricity.

The production of animal heat affords us another analogy: The action of the nerves upon the blood, it is believed, is the main *immediate* agent in the production of animal heat. Paralyze the nerves of a limb and you affect its temperature-preserving power. Paralytic limbs are generally below the natural temperature. Dr. James H. Miller, in 1833,* on establishing a galvanic current in the paralyzed limbs of a patient in the Baltimore Alms House, caused the temperature to rise, in a few minutes, from 62° to 89.° And Sir Wilson-Philip, by exposing arterial blood to the action of the galvanic battery, observed that its temperature became elevated some degrees; an effect which could not be produced, in the same circumstances, in venous blood, and which he could cause only once in the same portion of arterial blood.

The most striking analogies between nervous actions and those of the electrical fluid, are presented to us in certain animals which possess the power of giving, at will, an electrical shock. A power which seems to have been given to them to protect them from their enemies and to procure them food. The most remarkable of these animals are the electrical Ray or Torpedo, (*Torpedo electricus*, and other species,) of the Mediterranean;—the electrical Eel, (*Gymnotus electricus*,) of South America, and the *Silurus electricus*. All these fishes can at pleasure give an electrical shock to animals that are in connection with them by means of conductors. In the *gymnotus* this power is so energetic that horses and mules are stunned by them. Each of these remarkable animals possesses an apparatus of the same general character,—which is, a series of six-sided, aponeurotic tubes, aggregated like the cells of a honey-comb, into a mass, which, in the *Torpedo* is placed on each side of the head; in the *Gymnotus*, under the tail, and in the *Silurus*, around the body. Each of the cells is divided by a great number of membranous diaphragms, placed at short distances from each other throughout the tube. In the *Torpedo*, John Hunter counted 1182 of these tubes in one half of the apparatus. The spaces between the membranous di-

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visions in these tubes is filled with mucus, and fibrils of nerves, entering the tubes at the angles, pervade every part of the apparatus; the main nerve supplying the electrical organs being unusually large compared with the other nerves of the animal.

It seems pretty evident that the electricity, which these animals can accumulate, is derived, in some way, from the nervous system, and that the use of the arrangement of the divided tubes and mucus, is to collect the fluid and to increase its tension, or power of penetrating bodies. This opinion, is strengthened by the fact, that the exercise of this apparatus, by the animal in giving shocks, speedily exhausts its vital powers. Thus Humboldt and Bonplandt were only enabled, with safety, to obtain the electrical eels on which they experimented, by causing them to exhaust themselves by giving their shocks, and they assert that a long rest and abundance of food is necessary to the recuperation of their electrical powers. By the advice of the Indians, a drove of horses was driven into pool where these fishes abounded, and after the eels had spent the fury of their strength upon the horses, causing the death of one or two by drowning, they were so much exhausted that, approaching the edge of the pool, they were easily secured by harpoons. Mr. Todd, (Philosophical Transactions of Roy. Soc.) found that if the Torpedo be irritated, and caused to give a number of shocks in a short time, it soon died of the consequent exhaustion; but that if the nerve going to the electrical apparatus be cut, the animal loses the power of giving a shock, and may then be teased and irritated at pleasure without inducing exhaustion; an animal having these nerves cut, living much longer under these circumstances than one which had not been deprived of its power of giving the shock. Mr. John Davy, in his experiments on the same animal, also found that if the fish be often excited to give its shock that its digestion appeared to be completely arrested. In one of his experiments he found in the stomach of the animal, after its death, a little fish, which it had swallowed, but which it had not digested.

Another interesting fact is, that, according to the anatomical examination of M. Geoffrey Saint Hillaire, of those fishes, no particular nerve is especially appropriated to the function of developing electricity; for in the Torpedo it is the fifth pair of nerves which supplies the electrical apparatus; in the Gymnotus the nerves of this organ are cerebral in their origin; and in the Silurus those of the eighth pair supply this function. These interesting facts render probable the prophecy of M. Becquerel,* to whom I am indebted for many of the facts of this paper, "that if we one day discover that the electrical fluid enters into the phenomena of life, it will be through the study of the singular property possessed by these fishes."

An electrical shock has been obtained from a common animal. In 1686, Cotugno announced, that a student of medicine, while dissecting a living mouse, was much surprised to experience in the hand, an electrical shock, on touching one of the nerves of the animal with his scalpel. (Jour. Encyclop. de Bologne No. 3.) Analogous observations have been made by those who have employed acupuncture in the removal of diseases. Acupuncture consists in the introduction, into the body, of slender metallic needles, which are first driven through the skin by smart strokes with a small hammer, and then, by twirling them in the fingers, carried to any required depth. The most important vital organs have been transfixed in this way, without accident, and the operation is said to relieve many neuralgic affections, rheumatism, &c. It has been supposed by some that these needles acted by conducting electricity out of the system, and the following case seems to favour the supposition. M. Jules Cloquet† inserted a needle into the thigh of a patient to the depth of one inch; about six minutes afterwards, on touching the body of the needle with a wet finger, he perceived a slight shock, similar to that produced by the pole of a weak galvanic pile. At every new touch the patient complained of severe prickings and darting pains, proceeding from the

**Traite Exper. de Elect. et du Magn.* T. 3. p. 255.

†*Morand on Acupuncture*, Translated by F. Bache, 1828, p. 31.

point of the needle. Professor Recamier repeated the same experiment with the same result, and the presence of electricity, in the needle was further demonstrated by the attraction of light bodies and the electrometer. In these experiments the point of the needle becomes speedily corroded; and some are disposed to attribute the electrical phenomena to the corrosion of the needle,—but no such corrosion is produced in a dead subject, and it seems more probable that the action on the point of the needle was caused by its positively electrical state, according to known laws, than that the corrosion induced that electrical state in the needle.

Many other points of analogy might be given, did time permit, but I will be content with but one or two more.

One effect of a galvanic current is to counteract and modify the action of chemical affinity. Under the action of such a current the elements of all known chemical compounds may be separated, one class of these bodies being carried to one pole of the galvanic arrangement, the other to the other pole. Thus, when we decompose a salt, the acid is carried to the positive pole, and the alkali or base to the negative pole. Something analogous to this takes place in the animal body: for example; digestion could not commence unless the stomach secreted an acid, the muriatic principally, to dissolve the articles of food; and chylification could not be perfected without the aid of the alkaline secretion of the liver. The existence of Muriatic acid in the gastric juice, and of soda in the bile, would still continue, although we might never have swallowed either muriatic acid or soda, but we are constantly taking muriate of soda, which is always present also in the blood, and it is highly probable that the nervous influence is exerted in separating the elements of this compound at these two organs, in a manner analogous to that in which a galvanic pile would separate the acid and the alkali at its several poles.

Such analogies, in the body, are so striking as to have been evident to a common observer, although an uncommon man, the Emperor Napoleon. We are told by Becquerel, who got the anecdote from Chaptal, an eye witness, that when the Em-

peror saw repeated before him the phenomena of decomposition by the galvanic pile,* ‘he was struck with astonishment at seeing the transportation of the elements of the salts to their respective poles. After an instant of silence, turning to Corvisart, his physician, he addressed him in these remarkable words; “Doctor, behold the image of life!—the vertebral column is the pile, the liver the negative pole, and the bladder the positive pole.” Words, which although they do not evince much of physical or physiological accuracy, are yet remarkable as coming from one who had devoted his life to far other pursuits than the study of galvanism.

No two substances, in opposite chemical states, such as an alkali and an acid, can be brought into contact, out of the body, by means of imperfect conductors, without causing currents of electricity;—analogy makes it probable that similar currents are caused in the animal body by arrangements of this kind that are known to exist in it. Thus, the saliva is alkaline, the gastric juice is acid; perspirable matter is slightly acidified by acetic acid, the serous and sinovial fluids are alkaline; the urine is acid, the bile alkaline, and all these dissimilar bodies are in connection by imperfect conductors. Such arrangements among inorganic bodies, would give rise to electrical currents, and M. Donné has lately proven that they cause such currents in the animal body. He placed a plate of platinum, connected with one end of the wire of a galvanic multiplier, on the tongue, which is alkaline in its reaction, and put another platinum plate, connected with the other end of the wire, on the skin which is acid; the magnetic needle of the instrument was deflected fifteen, twenty, and sometimes thirty degrees. On placing the two ends of the wire of the multiplier, one in connection with the coat of the stomach, and the other in the gall-bladder, a very strong current of electricity was indicated. These experiments, however, only prove the existence of electrical currents in the body, the results of the action, on each other, of the dissimilar substances, which exist in the sys-

*Tome 1, p. 108.

tem; but they by no means prove that the nature of these secretions is dependent on the electrical state of the organs, or on the currents of electricity which pass among them. M. Matteucci supposed that he had thrown some light on the subject when he proved that the electrical currents ceased in an animal as soon as it was killed, or as soon as the nervous influence was cut off, although the acidity of the stomach, and the alkalinity of the liver still continued; and that the currents existed in the living animal even when the acid of the stomach and the alkali of the liver were severally neutralized, artificially, by proper reagents. He, therefore, believed that the different electrical states of these organs was due to nervous action, and that the secretions were modified by these electrical conditions. His experiments, however, have not as yet been verified: yet Orioli has ventured the supposition that the derangement of the secretions, in diseased states of the system, is a result of the derangement of the electrical conditions of the organs; and he proposes to study the natural electrical states of the organs in order that we may be able to restore them to the healthy electrical condition, when deranged, by contrivances adapted to that end.

In this connection it is well to notice another experiment of Sir Wilson Philip. This gentleman cut the eighth pair of nerves, on each side, in some rabbits, and found that parsley, which they had eaten, remained undigested in their stomachs; but that on causing a current of galvanism to pass along the course of the cut nerves, the gastric juice was again secreted, and digestion proceeded. The force of this experiment, however, is weakened by the fact, that similar effects were produced by subjecting these nerves to mechanical irritation, and it is hence objected that the galvanic fluid, in this instance, acted only as a mechanical irritant.

The action of the galvanic fluid on the nerves is capable, not only of causing contractions of the muscles, but also of causing sensations. Marianini, on subjecting a frog, which was prepared so that its posterior extremities were attached to the spine by the crural nerve only, to the galvanic current,

observed that when the current went from the trunk to the extremities of the nerves, it only produced contractions, unaccompanied by any signs of pain; while, when the current passed in the opposite direction, namely, from the extremities to the trunk, the contractions were less violent than in the former instance, but the animal gave undoubted evidence of great pain. This accords with the observation of Dr. James H. Miller, whose name I have already mentioned, who, in treating a case of paraplegia, in the Baltimore Alms House, by the current of galvanism evolved from a plate of silver on the nape of the neck and a plate of zinc on the inside of the knee, connected by a wire; one day, for experiment, reversed the position of the plates without the knowledge of his patient. The man immediately began to respire with great anxiety;—complained of the inversion of all his bowels threatening suffocation, and of a great deal of a new kind of pain; asserting that if the plates were not immediately removed they would kill him: as soon as the Doctor changed the plates again to their original positions he asserted that all was right again.

“According to Ritter, the electricity of the positive pole augments the vital forces, while that of the negative pole diminishes them; the first tumefies the parts, the second depresses them. The pulse of the hand held in contact with the positive pole is strengthened, while it is weakened if it is in contact with the negative pole. In the first case, according to this ingenious philosopher, we feel a sensation of heat, in the second one of cold. Objects appear larger, more brilliant and red, to an eye positively electrified, than to an eye negatively electrified, which sees them smaller, less distinct, and bluish.”

Humboldt placed two blisters, of the size of a five franc piece, on his shoulders. When the blisters were opened the serum flowed out, as usual, colourless. He covered the sore of the right shoulder with a plate of silver. A conductor of zinc was no sooner brought near it, than a new flow of humour was provoked, accompanied by a very painful burning sensation. This humour was not, like the first, white and of

a mild character. It acquired, in a few seconds, a lively red tint, and wherever it ran over the skin it left a mark of a reddish blue colour. The most malignant ulcer does not furnish an humour as acrid, nor as prompt in its action.

Not to multiply examples of the analogy between some of the actions of galvanism, and those of the nervous fluid,—for time reminds me that I have said enough, and it must already be evident that there are some striking points of resemblance between them,—we will pass on to the second division of my subject, the therapeutical application of galvanism. Before proceeding, however, I beg that I may not be misunderstood. While I make the assertion that there are striking analogies between the action of electricity, and nervous action, on the body, I am far from asserting that they are the same; it would be wholly unphilosophical to say so. Analogical reasoning can never be fully relied on, and should only serve to lead to new observations and experiments on Nature. At the same time, analogy is not to be entirely neglected, as it often serves to connect one discovery with another, and to lead to new ones; and although in the end it may be discovered to be erroneous, yet, while it stimulates to exertion and research, it cannot be denied that it may sometimes be highly useful.

It must have been long known that electricity exerts a powerful influence on the animal system. We have accounts that the shock of the *Torpedo* was used by the ancients in the cure of diseases, and to the present day it is still, probably, employed in intermittent fever; and the effects of the *Gymnotus* were formerly used, in Guiana, in the cure of paralysis. Among the earliest accounts that we have of the effects of lightning, we have those of persons, who were previously paralytic, having been restored by a partial shock of that agent; and when the identity of common electricity and lightning was established, and the electrical machine brought to a state of comparative perfection, the common electrical fluid was employed in a variety of modes, and with various degrees of success, in the cure of diseases.

One of the most remarkable instances of the remedial effects of the electrical fluid on record is that given by Mr. W. Scoresby, which I obtain from Becquerel. "The packet, New York, left America on the 16th of April, and on the 18th was near the western limit of the gulph stream, in 30° N. latitude. Here she encountered a tremendous storm. At half past five o'clock, on the morning of the 19th, the lightning, with a great crash, struck the ship and filled all the births with thick clouds of a sulphureous smoke. All the elements were in a most violent commotion. In a second discharge on the vessel, which took place along a metallic chain which the captain had caused to be fastened by one end to one of the masts, while the other plunged in the sea, having at its upper end a pointed rod of iron, the vessel appeared all on fire by the effect of the discharge, the chain of communication was melted by degrees. Concentrated by the conductor into a strong current, the electrical fire dispersed as soon as it penetrated into the sea, but a luminous vapour seems to rise from the water even to the clouds, while the re-action which operated on the vessel was so violent that several individuals fell prostrate on the deck. The vessel appeared to be on fire a second time; all the parts of the ship were filled, as before, with sulphureous vapours, which were so thick, that it was impossible to distinguish any thing at two paces distance. One of the passengers experienced a singular effect from the two discharges. A man of advanced age, infirm, and of a remarkable corpulency, was sleeping in his bed; he was so little in a state to take exercise, that, for three years, he had not walked over a space of half a mile, and he had not even appeared on deck since the commencement of the voyage. But after the discharges, this same person left his bed, mounted on deck, and went from one side to another with much ease and without manifesting the least pain, but in a state of mental aberration. Fortunately, the derangement of his intellectual faculties was only momentary, and the beneficial influence of the electricity on his infirmities more durable; for he not only preserved the use of his legs during the rest of the trip, but he was even able, when he landed, to go on foot a considerable distance to his hotel."

The application of common electricity to the cure of diseases may be said to have had its day. For a time when the subject was new, this agent was applied to almost every disease, and numerous were the cases, particularly of nervous disorders, which were cured or relieved by it, but as the novelty of the thing wore off, and consequently the faith of both the physician and the patient in the efficacy of this fluid, it got gradually into disrepute, and now scarcely any, but an old practitioner, has an electrical machine among the furniture of his office. Thus has it always been in medicine; a new remedy is first inordinately praised, and, after a time, when experience fails to justify the extravagant assertions and expectations which were at first made and raised, the remedy is just as inordinately decried.

When galvanic electricity was first discovered, among its earliest applications were those to medicine. Galvani himself employed it in this way; and up to the present day it has been occasionally used, with more or less propriety and intelligence; and with such success, when judiciously applied, as to justify the prophecy that before the conclusion of the present century it will be ranked among the most efficient of the therapeutical agents. The application of this powerful agent cannot, however, be successfully made except by those who are fully familiar with its laws and actions, and of the contrivances and arrangements by which a current of this fluid may be induced. Without this preliminary knowledge, one who attempted to employ it would be groping in the dark, and be as liable to produce injury as benefit to his patient. In proportion to the power and efficiency of any agent is the danger to be apprehended in its malapplication.

The galvanic current may be caused to act in various ways upon the system. Dr. Palaprat employed it for the purpose of cauterizing internal parts. A platinum wire being introduced into the part, placed in connection with one pole of a sufficiently powerful battery; the other pole of the battery being placed in connection with some other part of the body; the end of the platinum wire was immediately made white hot by

the galvanic current, and a tubular eschar, which separated in a few days, was the result. The same physician used the pile for introducing into the system certain medicinal agents, in the manner indicated in the following experiment. Having dried, as much as possible, the two arms of a female, he placed on one a little compress moistened with a solution of iodide of potassium, and on the other another compress moistened with a solution of starch; he covered each compress with a plate of platinum, and put them in connection with the poles of a pile of thirty pairs of plates, the starch being in connection with the negative pole. In a few moments the starch became blue, indicating the presence of iodine, resulting from the decomposition of the iodide of potassium, and which had been conveyed through the body, to the negative pole, by the galvanic current. In this manner, by using needles for the poles, introduced as in simple acupuncturation, the Doctor succeeded in conveying iodine, and other substances, to different parts of the body; and he asserts that in this way he was successful in removing engorgements that had resisted all the medications that had been previously employed.

Those who have studied the chemical action of the galvanic battery know, that when any salt, or other compound substance, is exposed to the action of its current, the acids of the compounds are soon transferred to the positive pole, and the alkalies or bases to the negative pole. Let any one repeat an experiment of Sir H. Davy's, and he will be convinced that such actions of the pile may take place, to a certain extent, through the animal body. Let him wash his two thumbs completely in distilled water, and then place them into two glasses, filled with distilled water, that are in connection with the two poles of a battery. After holding them in that position for a sufficient length of time, the galvanic current traversing his body, he will find, on examination of the water in the glasses, acids,—muriatic, phosphoric and sulphuric, in the positive glass, and fixed alkali in the negative glass, derived from the decomposition of the salts of the fluids of the body, by the agency of the galvanic current. It is evident, therefore, that in

addition to the stimulant or irritating action of a current of galvanism on the nerves, other effects may be produced by the acids, or the bases, of the compounds in the fluids of the body, the elements of which, separated by the electrical agency, are carried to the positive and negative poles respectively.

Davy exposed a piece of clean muscular flesh to the action of a galvanic pile of 150 pairs, for five days, the flesh being in connexion with water at each pole; and on burning the flesh, at the end of the experiment, none of the salts usually found in the ashes of flesh, were obtained; but in the water of the positive glass there were sulphuric, nitric, muriatic, and phosphoric acids, and in the negative glass, potash, soda, lime and ammonia; proving that the salts of the flesh had been decomposed, and their constituents carried out of the flesh to the several poles of the battery. On this principle it has been proposed to decompose, and destroy, urinary and other calculi in the body, and the method promises to be of utility, in the hands of persons who know how to apply it.

In the application of galvanism to the cure of diseases much, no doubt, depends on the direction of the current. A current passing from the trunks to the branches of the nerves, it has been seen, stimulates the muscles to contraction, without painfully exciting the nerves, while a current passed in the opposite direction, namely, from the ramifications to the trunks of the nerves, although it excites contractions, causes on the other hand, painful irritation. Some regard must be had to this circumstance, as well as to the power, continuance, and duration of the current, in its application to the animal economy.

Various modes of applying the galvanic fluid to the human body have been employed. Sir Wilson Philip used the small battery of Cruikshank; and it will be seen, by reference to his work "on the Vital Functions" that it was instrumental, in his hands, in relieving a number of persons of spasmodic asthma—one pole of the battery, the positive, being put in connection with a silver plate laid on a moistened spot on the nape of the neck, and the other, in the same manner, on the pit of the stomach. The same form of the instrument

was used by Dr. Munsell, who gives the history of six interesting cases, relieved by galvanism, in the 6th volume of this journal. In one of these cases, case 5th, that of a lady of 70 years of age, on whom the galvanic current was applied to the head,—one pole to the nape of the neck the other to the temple,—for the removal of a neuralgic affection, vulgarly called a sun-pain, a very remarkable effect resulted. The pain instantly ceased on the contact of the wires, and for a short time after the application of the galvanic fluid, her vision was rendered as clear and distinct as it ever had been during her life, so that she could read very small print without her spectacles.

Dr. Mansford, in his work on epilepsy, gives an account of another mode of applying a galvanic current. Two plates were taken, one of silver the other of zinc, and were fastened, by strips of adhesive plaster, the one on the nape of the neck and the other on the inside of the knee, on spots from which the cuticle had previously been removed by small blisters. The plates were connected together by a wire, soldered to each, which passed down the back. To moderate the irritating effects of the metals on the raw surfaces, a piece of moistened sponge was placed under each plate, and, under the zinc plate there was put, in addition, a piece of fresh muscle free from fat. Thus the patient was enabled to move about, without inconvenience, carrying his galvanic apparatus on his person, and subjected to the influence of a constant weak current of galvanism. The positive pole being near the brain, the negative on the extremity. It was necessary to remove and clean this apparatus every 12 or 24 hours, in order to renew the muscle, and scrape off from the zinc plate the crust of oxide which forms on it. In this way Dr. Mansford succeeded in relieving a number of cases.

This same apparatus was employed by Dr. James H. Miller, in the Baltimore Alms House, with decided success, in two cases of paralysis; and by Dr. Harris, of the United States Navy, one of the physicians of the Pennsylvania Hospital, in several cases of neuralgia. An account of the cases of both of

these gentlemen is recorded in the Amer. Journ. of Medical Science, vol. 14.

M. Sarlandiere applied the galvanic current to internal parts, by means of the introduction of needles of steel or platinum, as in acupuncture, passing the current through them. In this way M. Majendie succeeded in curing some cases of amaurosis, which had resisted the action of the most violent means that surgery could employ, such as blisters, inoxas, etc. The first experiment was made on a young man, attacked with amaurosis, with immobility of the pupil, on whom he first tried simple acupuncture, transfixing the nerves with his needles, without any beneficial result. The needles were subsequently placed, the one in the frontal nerve, and the other in the superior maxillary nerve, and put in connection with the two poles of a pile composed of twelve pair of plates, six inches square. At the moment of contact the patient experienced a painful shock in the course of the nerve,—the light affected him visibly, and the pupil contracted. After a treatment of fifteen days the disease was sensibly ameliorated, and the pupil regained its ordinary dimensions. In several other cases of incomplete amaurosis he obtained successful results. In a case of paralysis of the third pair of nerves, with deviation of the eye downward and outward, and depression of the upper eyelid, that had resisted the common modes of treatment, a single application of the current of electricity through needles inserted into the supra-orbital and sub-orbital nerves, caused a complete cure. Similar happy effects resulted from this mode of treatment in another case, that of paralysis of the sixth pair of nerves, with deviation of the eye inward and downward.

In other cases of paralysis it has been employed with success by a number of persons;—as well by Marianini, who treated his patients by a succession of shocks of electricity caused by the continual interruption of the current, as by Dr. Miller, who used the constant weak current of the plates of Mansford. It seems evident, in fact, that it is principally to nervous disorders that the galvanic current is applicable.

I have now given some of the analogies between nervous action and the action of the electrical fluid, on the animal body, and a few of the applications of this powerful agent to medicine. Were I to attempt to give the whole of them, a book would be the result, not a paper; and were all the speculations and theories, to which these analogies and actions have given rise, to be recorded in one work, it would be swelled into numerous tomes of ponderous size. That the study of the galvanic fluid has given rise to ardent aspirations and fanciful theories, cannot be denied; so have the magnificent discoveries of the astronomer; but the imaginings of the poets, or the conceptions of the theorists of science, have not affected the truth of the discoveries either in the one case or in the other; and the philosophical mind, while it may be delighted for a time with the beauties of the poetry of science, finds no difficulty in separating from it the unimaginative but instructive prose.

